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**PROJECT VELA UNIFORM
SECOND QUARTERLY
REPORT**

31 August 1961

Covering the Period 1 June to 31 August 1961

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Project Scientist: W. E. Danielson, Tucker (NJ) 7-1000, x3493



ABSTRACT

~~This report describes~~ instrumentation of a seismic research facility ^{is described} and preliminary efforts at interpreting spectrograms to assess their value in distinguishing man-made from natural seismic phenomena ^{are presented}. During this period, construction of a seismometer vault was started, a bread-board spectrum analysis and writeout equipment was completed, and a collection of taped seismic events was readied for analysis and interpretation.

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PART I

1. PURPOSE

Bell Telephone Laboratories, Inc., on behalf of the Western Electric Company, Inc., is participating in a one-year program for the Advanced Research Projects Agency (ARPA) on Project Vela Uniform. This project, one phase of the over-all Project Vela, is devoted to developing means for detecting nuclear detonations by analyzing seismic data. The Laboratories program under Project Vela Uniform is to explore the application of spectrum analysis and other signal progressing techniques to the problem of distinguishing disturbances caused by nuclear blasts from those caused by earthquakes and other natural phenomena.

2. PROGRESS REPORT

A seismometer vault is being constructed at Chester, N. J., and seven equipment channels for displaying seismic data — five spectrum analyzers and two heli-corders — are being placed into operation at the Whippany Laboratory. All components of a seven-channel telemetering link that will transmit data from the seismic station at Chester to the analyzing and display laboratory at Whippany have been procured. The telemetering receiving terminal at Whippany is ready for operation; the transmitting terminal at Chester will be ready by the time the vault has been completed. A telephone line to telemeter data directly from Chester to Whippany is being obtained to supplant the Chester to Murray Hill to Whippany routing used at present.

Analysis work continues to probe the basic question — can spectrum analysis serve as a useful tool for distinguishing nuclear detonations from earthquakes and other natural seismic phenomena? Tapes of nuclear blasts and earthquakes are being collected for analysis.

2.1 Equipment at Chester

Facilities approval has been obtained for construction of the seismic vault, and BTL has awarded (August 24) a contract for the construction work. The contract calls for completion by September 22; installation of seismometers will follow.

A 60-foot antenna for detecting geomagnetic disturbances was installed at Whippany early during this reporting period, but it picked up too much local

interference to generate useful displays. The antenna was then moved to Chester, where it was buried 6 inches in the ground and its battery power supply mounted on an adjacent telephone pole. Not enough data have been generated to judge the value of geomagnetic studies of this kind. Records from this antenna will be compared with those from microbarographs and seismometers to look for possible correlations.

The equipment for the terminal building at Chester is about 50 percent ready for operation.

2.2 Vela Uniform Laboratory at Whippany

2.21 Displays. One four-channel system, consisting of receivers, discriminators, spectrum analyzers, and a four-channel display, has been assembled and placed into part-time operation. In addition, a second helicorder has been procured; presently it is being used to display electromagnetic data. With the one channel of spectrum analysis and the helicorder previously placed into operation (see Paragraph 3.22 of the Project Vela Uniform First Quarterly Report), there are now five spectrum analysis and two helicorder displays at Whippany. When the new Chester seismometers become operational, it is planned that the following displays will be generated at Whippany:

1. One 0 to 1.5 cps spectrum analysis display
2. One 0 to 3 cps spectrum analysis display
3. One 0 to 6 cps spectrum analysis display
4. One 0 to 30 cps spectrum analysis display
5. Two helicorders.

2.22 Processing Equipment. In assembling the breadboard processing channels, it has been necessary to use a variety of components developed by BTL for other spectrum-analysis systems. Since none of these components was designed to operate at the relatively slow analysis and write-out rate needed for the Vela Uniform work, a great deal of effort has been expended in improvising, modifying, and adapting components. While this effort has produced a working system with four channels, it is felt that equipment parameters may still require modification. As experience is gained and more is learned about the spectral characteristics of seismic events, it will be possible to evolve increasingly appropriate hardware.

2.23 Tape Analysis. During this report period magnetic tapes from Bogert's library of digitized seismic events at Murray Hill have been generated, and taped records of several nuclear blasts have been secured from the University of Michigan through ARPA. Portions of these tapes were used as inputs for the breadboard four-channel system (see Paragraph 2.22); the results are given in Paragraph 2.3.

2.3 Analysis and Interpretation

The spectrum analysis and helicorder records were studied in a continuing program of familiarization with the features of seismic displays. Tapes of Murray Hill seismic records were played as described in Paragraph 2.23. From this work it is concluded that the Murray Hill tapes are of good quality, being free from noise that would cause artifacts on spectrum analysis displays. Of the six seismic events present on a tape recording received through ARPA, five were heavily obscured by noise, and are of marginal usefulness.

The tape-recorded events will be used for:

1. Making a parameter study of the spectrum analysis equipment.
2. Investigating the value of spectrum analysis in underground nuclear blast detection and classification. The capability to distinguish between bombs and earthquakes is a paramount need.

The Murray Hill tapes sample several earthquakes and nuclear blasts, occurring in the same general area, which were received at the same station. Part of the analysis program at BTL will be an attempt to discover whether transmission through the earth destroys or distorts the spectral characteristics of natural and artificial seismic disturbances beyond the point where classification is possible.

3. CONCLUSIONS

1. Work on the seismic vault at Chester is scheduled to be completed by 22 September. Installation of seismometers will follow immediately thereafter. Some of the equipment may be in operation by 1 November.
2. Processing, display, and telemetering receiving terminal equipment at the Whippany Laboratory are in partial operation, with some channels in operation on a 24-hour basis.
3. Equipment parameter studies continue.
4. Magnetic tape recordings of seismic events have been collected for future use in the program.

From the minimum of analysis done to date:

5. The spectrum-analysis records consistently permit an observer to distinguish between transient local phenomena and seismic events of distant origin.
6. Spectrum analysis of this type appears to provide some capability for detecting seismic events having marginal signal-to-noise ratios.

PART II. PROGRAM FOR THE NEXT INTERVAL

- 1. Construction of the Chester vault will be completed, and the seismometers will be installed.**
- 2. The 4-channel detection and analysis equipment for displaying live inputs will be completed.**
- 3. An analysis and display system for investigating tape-recorded seismic events will be assembled.**
- 4. The study of spectrum analysis equipment parameters will continue.**
- 5. Analysis effort will be directed to the problem of interpreting the fine structure of the spectra of teleseisms.**

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